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TITLE: **SELF EXTINGUISHING CANDLES AND METHOD OF MAKING SAME**

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SELF EXTINGUISHING CANDLES AND METHOD OF MAKING SAME

CROSS REFERENCE TO RELATED APPLICATIONS

[1] This application claims priority to a prior U.S. Provisional patent application, Serial No. 60/210,057, filed June 7, 2000, entitled Self Extinguishing Candles. The disclosure of the provisional patent application is incorporated by reference herein in its entirety.

FEDERALLY SPONSORED RESEARCH

[2] Not applicable.

REFERENCE TO MICROFICHE APPENDIX

[3] Not applicable.

FIELD OF THE INVENTION

[4] The invention relates to self-extinguishing candles and methods of making candles.

BACKGROUND OF THE INVENTION

[5] Since their earliest use, candles have provided a convenient and generally reliable source of light for mankind. While candles have varied substantially through the years, all generally comprise a solid fuel source (usually wax) within which a fiber wick is embedded. In their basic function, candles provide light once the fiber wick is lit by producing sufficient heat to melt the wax fuel to a liquid form which may be carried within the wick and burned. As the candle flame burns, the heat produced creates a pool of melted wax in the region of the wick. This liquified or melted wax is then carried up to the flame by capillary action within the wick. As the candle burns, and the wax fuel is consumed, the position of the flame moves downwardly upon the wick permitting the candle to produce a substantially continuous light.

[6] As long as the fuel is supplied through the wick via a capillary action to the flame, the flame continually burns down the wick. In many situations, the candle is lit and left alone to burn until the candle is manually extinguished or extinguishes itself. A typical candle will normally extinguish itself upon the disintegration of the wick or the elimination of the fuel supply to the wick.

[7] Many commercially sold wax candles, however, are often placed or formed in a glass or other fragile non-flammable container. Therefore, as the flame disintegrates the wick, the flame approaches the bottom of the glass candle holder, thereby causing the glass holder to experience excessive heating. In certain conditions, the excessive heating results in thermally induced cracking or breakage failures. Specifically, when the heat inside the glass container exceeds the heat stress limits of the glass container, the glass may crack or completely break. If a glass candle holder breaks, flying glass pieces, fire hazards, and burns from picking up hot pieces of glass and wax may result in various levels of injury.

[8] Typical candles will often self-extinguish when less than approximately 0.25 inches of wax residue is left in the bottom of the glass holder. However, allowing a candle to burn with only 0.25 inches of wax residue between the flame and bottom of the glass is often dangerous in that, as discussed above, the flame still provides excessive heat to the glass surface. To further separate the flame from the glass surface and to provide stability to the wick, the bottom end of the wick is typically inserted into a wick clip. An exemplary wick clip is often constructed of a thin metal or aluminum material which includes a wide base for supporting a hollow cylindrical ferrule, whereby the cylindrical ferrule is typically located in the center of the base. The center of the base often includes an opening allowing fuel access from underneath the base into the hollow ferrule.

[9] Alternatively, some candles are manufactured to include a wick holder formed from a round base with a cylindrical ferrule emanating from the center of the round base. The cylindrical ferrule is hollow as to allow one end of the wick to be reciprocally received therein. The upper portion of the ferrule is "S" crimped, without piercing the ferrule, to reduce the flow of fuel upward through the ferrule. The base of the wick holder includes a small opening in the center of the base which is concentric with, and the same diameter as, the opening in the cylindrical ferrule. The

bottom of the base, on the opposite side of the cylindrical ferrule, is completely sealed off by a hot-melt adhesive, thereby preventing fuel from traveling up the hollow ferrule.

[10] By reducing the flow of fuel within the wick holder, the wick holder restricts the supply of fuel to the candle wick when the flame burns the candle wick down to the top of the wick holder ferrule. By restricting the supply of fuel to the wick, the candle flame, upon burning down to the top of the wick holder, self-extinguishes before allowing the flame to approach the surface of the glass candle holder.

[11] The aforementioned candles are based on restricting the flow of liquid wax to the wick by a mechanical device. Therefore, the ability of the candles to self-extinguish depends upon the performance of the restricting device. If the restricting device fails to function, the candle would not self-extinguish at the desired point. Therefore, there is need for a candle that self-extinguishes at the a desire point with improved consistency.

SUMMARY OF THE INVENTION

[12] Embodiments of the invention meet the aforementioned need by one or more of the following aspects. In one aspect, a self-extinguishing candle is provided. The self-extinguishing candle includes a first portion formed of a candle base material, a second portion in contact with the first portion, and a wick inside the candle. The second portion includes at least one flame retardant and is substantially resistant to burning or flames.

[13] In another aspect, a method of making a self-extinguishing candle is provided. The method includes: (a) forming a candle body from a candle based material; (b) forming a flame-resistant block from at least one flame retardant; and (c) joining or attaching the flame-resistant block to the candle body.

[14] Additional aspects of the invention as well as objects and advantages provided by embodiments of the invention are apparent with the following description.

DESCRIPTION OF THE DRAWINGS

[15] Figure 1a-1c show a cross-sectional view a self-extinguishing candle in accordance with one embodiment of the invention.

[16] Figure 2 shows a cross-sectional view of a self-extinguishing candle in accordance with another embodiment of the invention.

[17] Figure 3a-3c show a cross-sectional view of a self-extinguishing jar candle in accordance with yet another embodiment of the invention.

[18] Figure 4a-4c show a cross-sectional view of a self-extinguishing jar candle in accordance with still another embodiment of the invention.

DESCRIPTION OF EMBODIMENTS OF THE INVENTION

[19] Embodiments of the invention provide a self-extinguishing candle which includes at least two parts: the first portion, i.e., the candle body, is formed of a candle base material. The second portion, i.e., the flame resistant block, is in contact with or attached to the first portion. The flame resistant portion includes at least one flame retardant and is substantially resistant to burning or flame. Typically, the self-extinguishing candle includes a wick inside the candle, although it is not always necessary to have a wick inside the candle. Wickless candles which are self-extinguishing may also be made in accordance with embodiments of the invention.

[20] Figure 1a is a schematic showing a cross-sectional view of a self-extinguishing candle manufactured in accordance with one embodiment of the invention. Referring to Figure 1a, the self-extinguishing candle 10 includes a candle body 12 and a flame resistant block 14. The flame resistant block 14 is attached at the lower portion of the candle body 12. A wick 16 is embedded in the central portion of the candle body 12, but not in the flame resistant block 14. When in use, the candle 10 continues to burn by consuming the candle body 12. After the candle body 12 is consumed, the wick 16 automatically extinguishes because the flame resistant block 14 does not provide fuel to the wick. Figures 1b and 1c are similar to Figure 1a except that the wick 16 extends part way or all the way into the flame resistant block 14, respectively.

[21] Figure 2 is a schematic showing the cross-sectional view of another self-extinguishing candle made in accordance with another embodiment of the invention. According to Figure 2, the self-extinguishing candle 20 includes a first candle body 22 and a second candle body 28. A flame resistant block 24 is placed between the first candle body 22 and the second candle body 28. Optionally, a wick 26 is embedded in the first candle body 22, the second candle body 28 and the flame resistant block 24. When the candle 22 is used, a consumer may light this candle at either end. After one candle body is consumed, the consumer may simply flip the candle over and light up the candle from the other side.

[22] Figure 3a is a schematic showing a cross-sectional view of a self-extinguishing jar candle manufactured in accordance with another embodiment of the invention. As shown in Figure 3a, the self-extinguishing jar candle 30 includes a self-extinguishing candle 33 contained in a container 31, such as a jar. The self-extinguishing candle 33 includes a candle body 32 and a flame resistant block 34. Moreover, a wick 36 is embedded in the candle body 32, but not in the flame resistant block 34. After the candle is lit, the wick 36 continuously consumes the candle body material until it is completely consumed. After wards, the flame will extinguish due to lack of fuel. Figures 3b and 3c are similar to Figure 3a except that the wick 36 extends half way or all the way into the flame resistant block 34, respectively.

[23] Figures 4a-4c show additional embodiments of the self-extinguishing candle. As illustrated in Figure 4a, the self-extinguishing candle 40 includes a candle body 42, a flame resistant block 44, and a wick 46. The flame resistant block 44 is in the shape of a cup or a sleeve, although other geometries are also acceptable. It is noted that the location of the flame resistant block need not be at the bottom of the candle. Other locations are possible so long as it either helps extinguish the candle flame after the desired candle body is consumed or prevents the flame from consuming selected parts of the candle.

[24] The candle portion of the self-extinguishing candle in accordance with embodiments of the invention includes a candle base material. The term "candle base material" refers to any material that can be used to form a candle. A suitable candle base material preferably is a solid

which upon melting, provides a fuel source to a burning wick. A suitable candle base material can be solid, semi-solid, or liquid. Although most candle base material is opaque or substantially opaque, a transparent, substantially transparent or translucent material can also be used to form the candle body. Consequently, the self-extinguishing candles in accordance with embodiments of the invention can be transparent, opaque, or translucent.

[25] A common form of candle base material is wax, which usually refers to a substance that is a plastic to brittle solid at ambient temperature and becomes a low viscosity liquid upon being subjected to elevated temperatures. Suitable waxes for forming the candle body include any known waxes, including but not limited to, paraffin wax, microcrystalline wax, beeswax, animal wax, vegetable wax, mineral wax, synthetic wax, and mixtures thereof. In addition to wax, semi-solids (such as petrolatum), liquids, synthetic polymers and mixtures of synthetic polymers with one or more organic compounds may be used as a candle base material or part of a candle base material. Other typically used candle fuel source components, such as hydrocarbon oil, stearic acid, Vybar®, etc., also may be included in the candle base material. The following U.S. patents disclose a suitable candle base material that can be used in embodiments of the invention: 6,063,144; 6,036,925; 4,855,098; 4,449,987; 4,332,548; and 4,005,978. The disclosures of all of the above U.S. patents are incorporated by reference herein in their entirety. It is noted that a wax can be used alone or with one or more additives or a gelling agent to form the candle base material, depending on the type of candles desired.

[26] The self-extinguishing candle can also have a transparent or substantially transparent candle body. Any transparent candle base material may be used in embodiments of the invention. For example, the following U.S. patents disclose a suitable transparent candle composition which may be used in embodiments of the invention: 5,879,694; 5,843,194; 5,578,089; 5,508,334; 5,132,355; 3,819,342; and 3,645,705. In addition, PCT Application WO 98/17243 discloses a transparent polyamide-based gel that can be used to form a transparent candle. The disclosures of all of the above U.S. patents and PCT Application are incorporated by reference herein in their entirety. In addition, U.S. Patent No. 5,961,967 discloses a multiphase candle containing locally

enriched regions of deliverable active ingredients. Such a candle may also be used in embodiments of the invention. Therefore, the disclosure of this patent is incorporated by reference herein in its entirety.

[27] In some embodiments, the candle body may be formed from a candle base material which is capable of undergoing a phase transition from opaque to transparent or vice versa. PCT Application WO 99/27042 discloses such a candle base material which is suitable for use in embodiments of the invention. The disclosure of this PCT application is incorporated by reference herein in its entirety. Moreover, U.S. Provisional Application Serial No. 60/148,614, entitled "Polymeric Candle Compositions and Candles Made Therefrom," filed on August 12, 1999 and U.S. Patent Application Serial No.09/590,863, filed on June 9, 2000 in the name of David Elliott, III, Richard L. Johnson, Wei Song as the inventors, disclose another candle base material which is capable of under going a phase transition from opaque to transparent. The disclosures of these provisional and utility applications are incorporated by reference herein in its entirety.

[28] The flame resistant block of the self-extinguishing candles in accordance with embodiments of the invention includes at least one flame retardant. It can be made from a composition containing a flame retardant. For example, a candle base material containing a sufficient amount of a flame retardant can be used to make the self-extinguishing block. Alternatively, it can be made entirely from one or more flame retardants. In addition to a flame retardant, any non-combustible additive may be used in making the flame resistant block. It should be noted that any flame retardant can be used in embodiments of the invention. For example, the flame retardants disclosed in *The Chemistry and Uses of Fire Retardants* by J.W. Lyons, Wiley-Interscience (1970), can be used to manufacture the flame resistant block. Thus, the disclosure of this book is incorporated by reference herein in its entirety.

[29] It is noted that a suitable flame retardant can be an inorganic compound, an organometallic compound, an organic compound, or a mixture thereof. The flame retardant can be liquid, solid, or semi-solid. Preferably, hydrophobic silica or liquid silicone is used as a flame retardant. Additional suitable flame retardants include, but are not limited to, lead-containing

compounds, arsenic-containing compounds, phosphorus-containing compounds, sulfur-containing compounds, alumina trihydrate, magnesium hydroxide, magnesium carbonate, calcium carbonate, boric acid, antimony trioxide, tris-1,3-dibromopropyl phosphate, ammonium phosphate, bis(bromochloropropyl) bromochloropropyl phosphate, chlorinated paraffin, polybrominated diphenyloxide, decarbromophenoxybenzene, tetrabromobisphenol A, hexabromocyclododecane, tetrabromophthlic anhydride, or mixtures thereof. Additional suitable flame retardants are disclosed in the following U.S. patents: 6,005,033; 5,886,072; 5,766,568; 5,710,202; 5,583,172; 5,578,666; 5,532,302; 5,521,003; 5,418,272; 5,344,855; 5,296,534; 5,027,416; 5,185,103; 5,151,225; 5,130,349; 5,030,674; 5,025,042; 5,011,736; 4,945,018; 4,921,897; 4,900,768; 4,885,318; 4,869,948; 4,808,647; 4,740,537; 4,671,896; 4,520,152; 4,456,654; 4,362,658; 4,350,793; 4,343,854; 4,320,038; 4,235,978; 4,194,068; 4,184,969; 4,154,775; 4,115,351; 4,094,850; 4,078,016; 4,067,930; 3,956,567; 3,953,650; 3,950,456; and 3,941,908. The disclosures of all of the above U.S. patents are incorporated by reference herein in their entirety. Moreover, suitable flame retardants include a phosphorus/nitrogen-containing oligomer or polymer as disclosed in U.S. Patent No. 5,409,976, a phosphorus/nitrogen-containing compound as disclosed in U.S. Patent No. 5,158,999, a halogenated aliphatic bisimide as disclosed in U.S. Patent No. 4,430,467, and thermally stable cyclic phosphonate esters as disclosed in U.S. Patent No. 4,842,609, and halogenated imide-containing polyols as disclosed in U.S. Patent No. 4,401,778. This disclosures of all of the preceding U.S. patents are incorporated by reference herein in their entirety.

[30] In some embodiments of phase-changing candles, paraffin wax with at least 20 carbon atoms per molecule (hereinafter "C_{20+} paraffin wax") is used. C_{20+} paraffin wax refers to a wax composed of mainly paraffins with 20 or more carbon atoms per molecule. In other words, the preferred C_{20+} paraffin wax is substantially free of paraffins with less than 20 carbon atoms per molecule. Nevertheless, a small amount of paraffins with less than 20 carbon atoms per molecule may be present in the C_{20+} paraffin wax. Preferably, the melting point of the C_{20+} paraffin wax should fall in the range of about 100° F. to about 200° F. (i.e., about 37° C. to about 93° C.), more

preferably in the range of about 100° F to about 170°F, and most preferably in the range of about 110° F to about 125° F.

[31] Paraffin wax is considered as a petroleum wax. It typically is macrocrystalline and brittle. Paraffin wax usually is composed of about 40 to about 90 weight percent of normal alkanes, with the remainder isoalkanes and cycloalkanes. Preferably, the paraffin wax does not include a substantial amount of hydrocarbons with less than 20 carbon atoms per molecule. Typical properties of paraffin wax are listed in Table I as follows. An example of suitable paraffin waxes can be obtained from Bareco under the trade name of Bareco Paraffin 120/125.

TABLE I

Typical Properties of Paraffin Wax

FLASH POINT, CLOSED CUP. °C	204*
VISCOSITY AT 98.9°C, MM^2/S	4.2 - 7.4
MELTING RANGE, °C	46 - 68
REFRACTIVE INDEX AT 98.9°C	1.430 - 1.433
NUMBER AVERAGE MOLECULAR WEIGHT	350 - 420
CARBON ATOMS PER MOLECULE	20 - 36
DUCTILITY/CRYSTALLINITY OF SOLID WAX	friable to crystalline

* value is a minimum.

[32] In some embodiments, wax alone is used to form the candle body. In other embodiments, a polymer or a polymeric material is used with a wax to form the candle base material. In still other embodiments, a wax is mixed with one or more additives to the form the candle base material. The term "polymer"used herein includes both homopolymer and copolymer. A homopolymer is a polymer obtained by polymerizing one type of monomer, whereas a copolymer is a polymer obtained by polymerizing two or more types of monomers. "Block copolymer" refers to a copolymer in which like monomer units occur in relatively long, alternate sequences on a chain.

[33] The polymer used in the candle base material primarily functions as a gelling agent. Any polymer which is capable of forming a three dimensional network or a gel through physical

crosslinking may be used in embodiments of the invention. Preferably, suitable polymers include, but are not limited to, a copolymer with at least two blocks, i.e., a diblock copolymer, a triblock copolymer, a radial block copolymer, a star polymer, a multi-block copolymer, and mixtures thereof. In more preferred embodiments, the polymer includes at least one triblock copolymer, radial block copolymer, star polymer, or multi-block copolymer. The copolymer includes at least one rigid block and one elastomeric (or rubber-like) block. The rigid blocks of the copolymer form rigid domains through which physical crosslinking may occur. The physical crosslinking via these rigid domains yields a continuous three dimensional network. In the presence of heat and shear or solvent, the rigid domains soften and permit flow. After cooling or solvent evaporation, the rigid domains reform and harden, locking the elastomeric network in place. U.S. Patents No. 5,221,534, No. 5,879,694 and No. 5,578,089 disclose examples of such block copolymers, and the disclosures of the patents are incorporated by reference in their entirety herein.

[34] A diblock copolymer includes two blocks within its chains: a rigid block and an elastomeric block. The rigid block typically may be composed of polystyrene, polyethylene, polyvinylchloride, phenolics, and the like; the elastomeric block may be composed of ethylene/butadiene copolymers, polyisoprene, polybutadiene, ethylene/propylene copolymers, ethylene-propylene/diene copolymers, and the like. As such, suitable diblock copolymers include, but are not limited to, styrene-ethylene/propylene copolymers, styrene-ethylene/butadiene copolymers, styrene-isoprene copolymers, styrene-butadiene copolymers. In some embodiments, a diblock copolymer is used along with one or more triblock copolymers, star polymers, radial copolymers, and multi-block copolymers.

[35] A triblock copolymer includes two rigid blocks at either end and a middle block which is elastomeric within its chains. This is a preferred triblock copolymer structure, although a triblock copolymer with two elastomeric end blocks and a rigid middle block also can be used. Suitable triblock copolymers include, but are not limited to, styrene-ethylene/propylene-styrene copolymers, styrene-ethylene/butadiene-styrene copolymers, styrene-isoprene-styrene copolymers, and styrene-butadiene-styrene copolymers. Multi-block copolymers are similar to diblock

copolymers or triblock copolymers, except that the multiple block copolymers include additional elastomeric blocks and/or rigid blocks.

[36] In addition to the linear chain structure, branched homopolymers or copolymers, such as a radial polymer and a star polymer, also may be used. It should be noted that one or more functional groups may be grafted onto the chain of any of the aforementioned polymers. In other words, any of the above polymers may be modified by grafting. Suitable functional groups for grafting depend on the desired properties. For example, one or more ester groups, silane groups, silicon-containing groups, maleic anhydride groups, acrylamide groups, and acid groups may be grafted. In addition to grafting, the above polymers may be hydrogenated to reduce unsaturation before they are used.

[37] It is noted that additional suitable block copolymers may include, but are not limited to, polystyrene/polyester, polyether/polyamide, polyether/polyester, polyester/polyamide, polyether/polyurethane, polyester/polyurethane, poly(ethylene oxide)/poly(propylene oxide), nylon/rubber, and polysiloxane/polycarbonate.

[38] Generally, the weight average molecular weight of a suitable polymer is in the range from about 10,000 to about 1,000,000, preferably from about 70,000 to about 400,000. The rigid block content may range from about 5% to about 80%, preferably from about 20% to about 40% by weight.

[39] Numerous commercially available block copolymers may be used in embodiments of the invention. For example, various grades of copolymers sold under the trade name of Kraton® from Shell Chemical Company can be used. In addition, copolymers sold under the trade name of Vector® available from Dexco and Septon® from Kuraray also may be used. Table II lists some commercially available block copolymers which may be used in embodiments of the invention.

TABLE II

Copolymer	Block Type	Polystyrene Content(%)	Comment
Kraton® G 1702	SEP	28	hydrogenated diblock
Kraton® G 1701	SEP	37	hydrogenated diblock
Kraton® G 1780	SEP	7	star polymer
Kraton® G 1650	SEBS	30	hydrogenated triblock
Kraton® G 1652	SEBS	30	hydrogenated triblock
Kraton® D 1101	SBS+SB	31	triblock and diblock mixture (85:15)
Kraton® D 1102	SBS+SB	28	triblock + diblock (85:15)
Kraton® D 1133	SBS+SB	35	triblock + diblock (66:34)
Kraton® FG 1901	SEBS	30	triblock (hydrogenated and functionally grafted with 1.7% of maleic anhydride.
Septon® 1001	SEP	35	Hydrogenated diblock
Vector® 6030	SB	30	Unsaturated diblock
Vector® 8550	SBS	29	Unsaturated triblock
Vector® 2518P	SBS	31	Unsaturated triblock
Solprene® 1430	SB	40	Unsaturated diblock

Note: SEP denotes to styrene/ethylene/propylene copolymers
SEBS denotes to styrene/ethylene/butylene/styrene copolymers
SB denotes to styrene/butadiene copolymers
SBS denotes to styrene-butadiene-styrene copolymers

[40] It should be recognized that block copolymers are not the only polymers that can be used in embodiments of the invention. Other types of polymers also may be used. Homopolymers which are capable of effecting strong molecular interaction between polymeric chains can be used. One such example is butyl rubber, which can thicken oil due to its compatibility with oil and high molecular weight. Specifically, a polybutadiene polymer sold under the trademark of Solprene® S200, which is available from GIRSA Industrias Negromex, S.A.de C.V. (INSA), can be used. Other homopolymers capable of forming hydrogen bonding may include polyamide, polyester, etc.

[41] The amount of a polymer present in a candle base material may range from about 0.1 wt.% to about 35 wt.%, although other composition range is acceptable. Preferably, a polymer is present in the candle base material from about 3 wt.% to about 30 wt.%. In embodiments where

both a diblock copolymer and a triblock copolymer are used, the triblock copolymer may range from about 3 wt.% to about 30 wt.%, and the diblock copolymer from about 1 wt.% to about 20 wt.%.

[42] In formulating a candle base material, the wax and polymer may be present in any amount. In some embodiments, a candle base material may be made from the following components: a paraffin wax with at least 20 carbon atoms per molecule in an amount of about 2 to about 96% by weight; a block copolymer in an amount of about 2 to about 35 percent by weight; a PAO in an amount of 0 to about 96 % by weight; and a white oil in the amount of 0 to about 96% by weight. Additional additives and objects may be included during the manufacturing of candles.

[43] Candle base materials and candle bodies in accordance with embodiments of the invention may be prepared by blending a hydrocarbon oil and a wax with one or more triblock, radial block, and/or multi-block copolymers, star polymers, or mixtures thereof, in desired amounts. A diblock copolymer may also be optionally included. In general, the higher the polymer content, the stiffer the gel.

[44] In some embodiments, a hydrocarbon oil and a suitable wax are first heated to a temperature in the range of about 50 °C. to about 150 °C., at which point a polymer is added under agitation to the desired weight percent as set forth herein. After sufficient time for the copolymer to dissolve in the mixture, the composition is poured into a mold or a jar containing a wick. Alternatively, a wick may be added thereafter, and the composition is allowed to cool to a stiff gel.

[45] Preferably, the candle is formed by cooling the candle base material in a mold or jar. A mold is used to impart external features, for example, a pillar candle, if desired. Conventional jars, clear, colored or otherwise decorative, such as sculpted, etched, cut glass, etc., may be employed for holding the candle. More preferably, clear glass jars are used for a jar candle.

[46] Candle base materials and candle bodies also may be formed by blending a suitable polymer (or a polymer blend) and a hydrocarbon oil and heating the mixture to a temperature in the range of from about 50°C. to about 150 °C. to dissolve the polymer (or the polymer blend) in the oil. A wax is then added under agitation. The wax is mixed with the hydrocarbon oil and the copolymer. Mixing may be carried out in any conventional manner. Upon cooling, a stiff (and

sometimes opaque) gel forms.

[47] In addition to a wax and a polymeric material, a hydrocarbon oil may be used in forming a candle base material. It is noted that a hydrocarbon oil may used with or without a polymeric material in formulating a candle base material. Hydrocarbon oil refers to any oil that is primarily composed of one or more compounds with hydrocarbon moieties. Suitable hydrocarbon oils include, but are not limited to, vegetable oil, animal oil, mineral oil, esters, or other oil-soluble liquids. It also includes refined, aromatic-free paraffinic and naphthenic oils, solvents, synthetic liquid, hydrogenated or unhydrogenated oligomers of polybutene, polypropylene, polydecene, and polyterpene. Other polyolefins also are suitable.

[48] A preferred mineral oil is white oil which is colorless and transparent and generally is recognized as safe for contact with human skin. Another preferred hydrocarbon oil is poly-α-olefins ("PAOs"). The term "poly-α-olefin" refers to a class of saturated olefin oligomers. A typical poly-α-olefin includes various amounts of dimers, trimers, tetramers, pentamers, hexamers of an α-olefin. A preferred PAO is oligomers of 1-decene, although it may be oligomers of any other α-olefins.

[49] The self-extinguishing candles in accordance with embodiments of the invention can be made by forming the candle body and the flame resistant block simultaneously or sequentially. In a preferred embodiment, a composition containing a suitable flame retardant in liquid form is poured into a glass jar or other suitable containers. After the composition solidifies, a candle composition in liquid form is poured into the glass jar on top of the flame resistant block. A wick is provided in the candle composition. After the candle composition solidifies, a self-extinguishing candle is formed. With slight modifications, a free standing candle as illustrated in Figure 1 or Figure 2 can be manufactured.

[50] The self-extinguishing candles in some embodiments employ a wick, typically of porous material which may be either waxed or unwaxed and of the thickness appropriate for the particular candle design. Any wick may be used. The wick may include a decorative feature, for example, striping, coloring, impregnation or coated with material for special effects, such as to

provide a colored flame, sparkles, etc., if so desired.

[51] The self-extinguishing candles in accordance with embodiments of the invention also may contain one or more additives such as stabilizers, U.V. inhibitors, anti-oxidants, colorants, fragrances, flame retardants, and the like to an extent not affecting or decreasing the desired properties of the candle. With respect to antioxidants, specific reference is made to 2, 6-di-tert-butyl-4-methylphenol known as "BHT," which is generally employed at about 0.01 to about 1 weight percent. Other antioxidants also may be used. These additives can be placed in the candle body, the flame resistant block, or both.

[52] Colorants may be added to the candles. The candles may be multicolored or have colored layers. The latter is achieved by forming one colored layer, allowing the layer to cool, and overlaying with a second colored layer, and so on. Other designs can be employed, such as single or multi-color swirls. Such swirls can be achieved by adding the color to the candle base material at a time during cooling of the composition but prior to complete solidification, and gently stirring the composition. Still other design variations are apparent to those skilled in the art.

[53] In addition to colorants, ornamental features may be embedded within the candle body, the flame resistant block, or both. Such features may be either insoluble or soluble in the respective composition of the candle, as desired. Use of such ornamental features allows a possibility not heretofore available in decorative features, as virtually any decorative object can be incorporated within the candle body, provided generally that such decorative feature does not adversely affect the burning capacity of the candle in an undesired way.

[54] Notwithstanding the above, decorative and other functional features that interfere with the burning of the candle may be incorporated, if so desired. For example, in suitable candle designs, decorative features located near the periphery of the candle and not in communication with the wick or flame will not adversely affect the operation of the candle and may thus be of any sort desired. Such a decorative feature may be placed in the candle, for example, by addition to the candle base material after sufficient cooling of the melt but before complete solidification.

[55] Exemplary insoluble decorative features include stars, glitter, sparkles, ribbons, air

bubbles of various size, etc. A pearlizing agent may be used in the candle. Other decorative additives, such as those that cause special effects, e.g., sparkling, flame coloring, etc., or mixtures thereof, also may be added to the candle base material of the candle in effective amounts and as desired. In addition, fluorescent and phosphorescent pigments or dyes may be added to enhance the appearance of the candle. Similarly, candles with buried or hidden messages may be made. Pending U.S. Patent Application Serial No. 09/007,838, entitled "Hydrocarbon Gels as Suspending and Dispersing Agents and Products," filed January 15, 1998, discloses a suspension system which can be used in embodiments of the invention. The disclosure of this patent application is incorporated by reference in its entirety herein.

[56] Fragrances, for example, cinnamon, spice, bayberry, pine, essence oils, etc., also may be used in a manner similar to the way wax candles employ pleasing aromatic additives. Any fragrances soluble in the candle composition may be used in making the candles. These fragrances can be employed by inclusion into the hydrocarbon oil. Alternatively, if the fragrance is particularly volatile, it is preferably added to the cooling composition prior to complete solidification. Fragrances are generally employed at up to about 20% by weight of the total candle base material. However, it is recognized by those skilled in the art that fragrant additives can be used up to their characteristic solubility level in the composition of the candle.

[57] The self-extinguishing candles in accordance with embodiments of the invention may further contain a functional additive, such as an insect repellant, for use in the same capacity as conventional candles containing such an additive. For example, U.S. Patent No. 5,387,418 discloses one such insect repellant compound that may be employed in the candles. The disclosure of the patent is incorporated by reference herein in its entirety. Citronella oil is another example of an insect repellant that may be used in embodiments of the invention. These additives are used in the conventional amounts as known in the art.

[58] A demonstrated above, embodiments of the invention provide a self-extinguishing candle which may have one or more of the following advantages. First, because the candle extinguishes automatically after the candle base material is consumed by the candle flame, there

is no need for a candle extinguishing device, such as a candle snuffer. Due to its self-extinguishing feature, consumers need not monitor the burning of the candle, thus providing peace of mind to consumers. Also due to its self-extinguishing feature, fire safety should improve. Finally, due to its design simplicity, it is relatively cost effective to manufacture the self-extinguishing candle. Other advantages are apparent to a person of ordinary skill in the art.

[59] While the invention has been described with respect to a number of embodiments, modifications and variations exist. For example, instead of placing a single flame resistant block in a candle, multiple flame resistant blocks may be used. The flame resistant block need not be opaque; it can also be transparent or translucent. Colorants may also be added to the flame resistant block to enhance aesthetic appeal. The appended claims intend to cover all such variations and modifications as fall within the scope of the invention.

[60] What is claimed is: